"(2) The machine compels the deposit of a perfect and accurate ballot, of the form chosen by the voter.

"(3) It restricts the voter absolutely to the limits of the law and permits him freedom as absolute in voting within that limit.

"(4) Blank and defective ballots, the usual fault of ordinary methods of voting, are entirely done away with and no man loses his vote through defect of the system, or fault of his own, if he votes at all. The disfranchised voter becomes unknown.

"(5) Fraudulent voting is impossible as well as errors in voting.

"(6) The vote cast is registered, vote by vote, with absolute accuracy and certainty.

"(7) The result can be declared immediately upon the close of the polls, having been already completely counted.

"(8) The cost of the system is so much less than that of the old method that the machines usually pay for themselves in from three to seven years.

"The whole case may be summarized in a sentence: 'The machines retain all the virtues and exclude all the vices of the old methods of balloting.' Their use would be entirely justified, even though they involve a more costly, rather than a much less expensive system. Their adoption is looked upon by your committee as promoting good politics, good morals and good finance."

The possible ultimate result of the general introduction of these new methods of election upon the freedom of the ballot and the honesty and accuracy of the count, and upon the future politics and economics of the state and nation, no one can probably quite realize or predict; but that this insurance of a full vote and an honest one will tell for good government, and the purification of parties and their methods, no one can doubt. As the representative of the Patent Office said, in his testimony before the Committee of Congress regarding the proposed, and later-enacted, measure legalizing the voting machine in federal elections we cannot doubt that "It is the last and best contribution to the science of good government."

Judge Cooley said that, in his opinion such a method is a 'constitutional right' of every voter. The most surprising fact is, perhaps, that in the case above referred to, there was but one protest, in the city of Ithaca, out of over 2500 voters. Every inspector of election signed a certificate to the effect that the experiment was absolutely satisfactory, and the only objections heard were from one 'party-leader,' and the only adverse interests discovered were those affected by the abolition of ballot-printing, which is a much larger item of cost—at political prices—than is usually supposed. Each printed ballot costs from four to twenty cents, at the various elections, municipal, state and general.

R. H. THURSTON.

ITHACA, December, 1899.

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*A COMPLETE MOSASAUR SKELETON, OSSEOUS AND CARTILAGINOUS.**

IN the spring of 1898, Professor S. W. Williston's fine memoir upon the Kansas Mosasaurs seemed to cover the subject completely, summing up all the facts derived from the great Kansas University collection, as well as many of the results of the labors of Cuvier, Owen, Marsh, Cope, Dollo, Baur, and others. But it appears impossible to say the last word in paleontology. Professor Williston himself has recently described a portion of the nuchal fringe of *Platecarpus*, as well as the epidermal fin contours. The remarkable specimen which has recently been mounted in the Marine Reptile Corridor of the American Museum throws new and welcome light not only upon *Tylosaurus*, but upon the anatomy of the Mosasaurs in general.

Together with the practically complete bony skeleton, are seen cartilages of the throat and chest, portions of the larynx, trachea, bronchi, the epicoracoids, as well as the suprascapulæ, the sternum and sternal ribs. Originally these parts were preserved entire, and we must deeply re-

* Extract from Memoirs of the American Museum of Natural History, Vol. I., Part IV.

gret that before this specimen came into possession of the Museum, much damage was done to the relatively inconspicuous cartilages, in course of removal of the bones. Nevertheless Mr. Bourne, of Scott City, Kansas, who excavated the fossil, deserves great credit for the skill and care with which the conspicuous parts were removed.

The specimen reached the Museum in a series of large slabs of Kansas chalk and was worked out in such a manner that all the contours of the original slabs are preserved and fitted together by their edges, as in the original bedding; therefore the great lizard with all its parts, excepting a few minor pieces, lies exactly as it was imbedded. The original matrix surrounds practically all the bones, and can be distinguished from the buff-colored outlying plaster, by its somewhat darker shades. The whole is mounted upon a panel twenty-five feet long and permanently placed in a corridor which is to be devoted to marine reptiles.

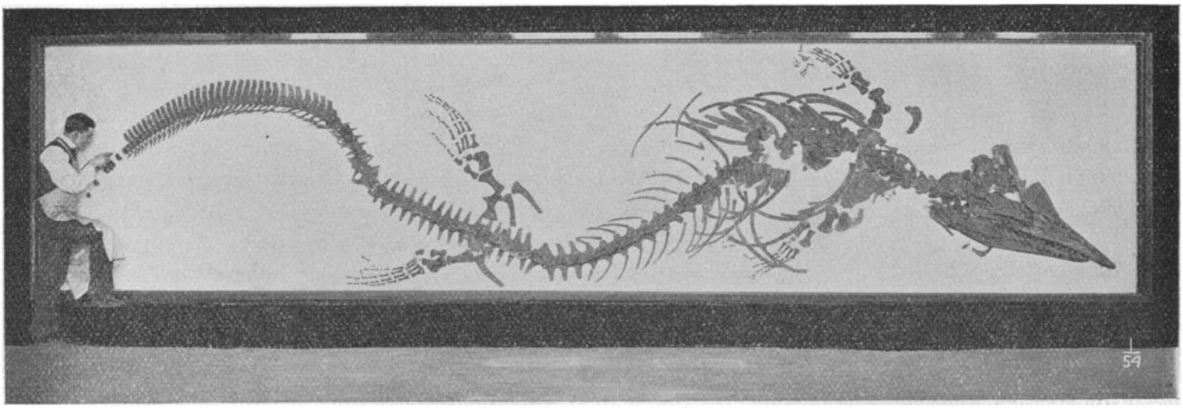

FIG. 1. Complete skeleton of *Tylosaurus dyspelor* in frame. $\frac{1}{54}$ nat. size.

The animal lies outstretched upon its ventral surface, so that all the bones are exposed upon the dorsal or lateral surfaces, excepting the left humerus and ulna, which are overturned. The skull is crushed to the left, together with the vertebræ, as far back as the 6th dorsal. From the 7th to the 10th dorsals the vertebræ are confused and displaced. The 11th dorsal to 29th caudal are horizontal with the transverse processes outspread and the spines crushed to the right and left. The remaining caudals, 30th–70th, lie upon the left side apparently in a natural position. The pelvis and hind paddles have evidently shifted backwards in settling, so that the mooted question of the position of the sacral vertebra cannot be positively settled by this specimen.

This specimen agrees very closely in size with Cope's cotype of *T.* (*Liodon*) *dyspelor*, founded in 1871 at Fort Wallace, Kansas, and described by him in the 'Cretaceous Vertebrata' (p. 167). The skull agrees exactly in size with the fine one mounted in the Munich Museum, described by Merriam (1894, Taf. II.) as *T. proriger*. Size is no criterion, or at best an uncertain criterion of a species, but Williston advances (1898, p. 175) no other satisfactory means of separating *T. dyspelor* from *T. proriger*. Thirty-five feet is the length assigned by this author to the largest Tylosaurs, a length considerably exceeding that of the present specimen. It is evident, however, that a

young *T. dyspelor* might exhibit exactly the measurements of *T. proriger*.

According to Williston the tail terminates very abruptly in *Tylosaurus proriger*, in contrast with its gradual and slender termination in *Platecarpus*. If this was the case in this specimen of *T. dyspelor*, we should not allow more than 15 inches or 38 centimetres additional, giving us a total length of about 29 feet or 8.83 metres. The *proportions* of different regions of the body are very characteristic of different genera of Mosasaurs. In this individual the total of 29 feet or 9 metres is roughly distributed as follows:

	Feet.	Metres.
Head and jaw	4	1.22
Neck	2	.61
Back	8	2.44
Tail	15	4.56
Total	29	8.83

Thus the back is four times the length of the neck, twice the length of the head, and about one-half the length of the tail. In other words, the tail is longer than the other regions of the body combined. These proportions are carefully observed in Mr. Knight's restoration.

There are positively *seven cervicals*, the number assigned to all the American Mosasaurs by Williston, and this point is of considerable importance as bearing against the supposed Dolichosaurian affinities of the Mosasaurs. In this specimen there are certainly *twenty two dorsals*, while Williston assigns *twenty-three dorsals* to *Tylosaurus proriger*. Merriam assigns twenty-three dorsals to *Tylosaurus* (*op. cit.*, p. 15). Williston is undoubtedly correct in placing the pelvis upon the first non rib-bearing vertebra, which thus represents the *sacral*.

*In this specimen, as in the living Monitor lizards, the 30th vertebra behind the head is distinguished by the absence of a rib, and by the sudden expansion of the diapophysis. This first expanded vertebra, as determined by Williston, must be considered the sacral, analogous with the most anterior of the *two* sacrals in *Varanus*. This vertebra is not perceptibly different in size from the pygals behind it. Unfortunately the tips of the diapophyses are not preserved, and there is no means of demonstrating positively that the ilium was attached by joint or ligament.

There are no lumbars. The number of pygals, or non chevron-bearing caudals, cannot be determined, because many chevrons are not exposed.

The vertebral formula is therefore as follows:

Cervicals	7
Dorsals, with sternal ribs	10
Dorsals, with floating ribs	12
Sacrals	1
Caudals and pygals	72 + (= 86).

A most interesting feature is the adaptive modification of the mid-caudal centra and spines, apparently for the support of a dorsal *caudal fin*. Dr. W. D. Matthew first directed the writer's attention to this structure.

Williston has figured the caudals of *T. proriger* as having spines of a nearly uniform height, while in *Clidastes velox* (*op. cit.*, p. 152) he describes an extension of the spines as probably designed to support a fin. This specimen of *T. dyspelor* shows as evidence of a fin:

1. A slight upward elongation of the spines in the mid-caudal region, beginning at C. 24 (in which the spine measures 10 centimetres) to C. 39–40 (in which the spine rises to 11 centimetres) and subsiding to 10 centimetres in C. 58. At the same time the spines change from a pointed and backwardly directed to a more square, upright, and truncated form. The vertical spine is upon C. 39; in front of this the spines of C. 1–38 lean backwards; while behind this the spines of C. 40–70 lean forwards, or are nearly upright. 2. There is some further evidence that the *upward*

curvature of the spine, is natural, and not due to post-mortem disturbance. This curve is beautifully indicated between C. 30 and C. 63; behind which the vertebræ dip down into the extremity of the tail. It is difficult to verify the existence of this curve in the living state by the measurement of the superior and inferior diameters of the centra. So far as measurements can be relied upon they tend to show that the vertebral centra were slightly longer above than below and thus produced the curve; the relations of the greatly reduced zygapophyses and the antero-posterior width of the spines also point to the same conclusion, for they show that if this column were straightened out the spines would come into contact. This condition is so unique, however, that it must be put forward with reserve.

The sharp ventral flexure or angulation of the tail of *Ichthyosaurus*, below the swelling of the caudal fin is not analogous to the very gradual upward curve in *Tylosaurus*.

We are now enabled to form a very clear idea of the general structure of the thorax, although certain details are still missing. All the true ribs are preserved on both sides, and, in spite of the havoc wrought in the removal of the chest region, we find all but one of the cartilaginous ribs on the left side and extensive portions of those on the right, as well as the central area of the sternum. The careful studies and drawings of this region by Dr. J. H. McGregor show clearly the relations of the actual and restored region, part of the preserved region being covered by the vertebræ and ribs.

The *cartilaginous ribs*, consist of broad bands which are closely concentrated and parallel as they converge towards the sides of the sternum, affording an exceedingly strong support for the thorax. The *floating* ribs decrease steadily in length and curvature. The coracoids do not unite in the median line as represented by Marsh, nor are they approximated as restored by Dollo in *Plioplatecarpus*. They are widely separated by epicoracoid cartilages having a united transverse diameter of about 22 centimetres. The inner ends of the bony coracoids are thus nearly nine inches apart. About one-half of the *sternum* is visible or preserved; as the cartilaginous ribs on the left side are nearly *in situ*, and those on the right approximately so, it is evident that the sternum had a triangular outline, thinning posteriorly for the junction of the 10th pair of cartilaginous ribs.

The sterno-coracoid plate thus corresponds closely with the Lacertilian type and bears a general resemblance to those of *Trachydosaurus*, *Varanus* and *Cyclodus*, as figured by Parker. There is no evidence of the presence of an episternum (interclavicle).

Behind the basioccipital is observed a supposed lateral cartilage of the larynx? *lx.* and its mate? *lx.* appears below just between the right pterygoid and quadrate. A bit of cartilage appears behind the left quadrate, another mass in front of the right quadrate, while the trachea extends from below the axis, is unfortunately destroyed as far back as the 5th rib, and diverges into the two bronchi just behind the coracoids. The tracheal rings are well exhibited.

The appendicular skeleton is remarkably well preserved. The *scapulæ* are fully exposed upon both sides, with the characteristic short and broad bony blades and the extensive crescentic cartilaginous suprascapulæ.

COMMON CHARACTERS OF FORE AND HIND PADDLES.

The metapodials and podials are somewhat displaced, but they enable us to make a reconstruction of the manus, aided by Williston's excellent photograph and outline of the paddle in *T. proriger*.

1. *Hyperphalangism* is a chief characteristic of the Tylosaur extremities. Williston's photograph shows 47 actual elements, to which 3 are added in his restoration of

T. proriger, making 50. Thirty-eight (38) elements are preserved in the left *fore paddle* or manus and 44 are inserted in our restoration, or 5 metacarpals and 39 phalanges. In the *hind paddle*, or pes, 33 metatarsals and phalanges are preserved on the left side (including an isolated phalanx which lies above the 50th caudal).

The phalangeal formula is *estimated* as follows :

		MANUS.	PES.
Digit	I.	5	5
	II.	8	8
	III.	8	8
	IV.	9	8
	V.	9	6
		T. dyspelor.	*T. dyspelor.*

It is apparent, so far as we can judge from this specimen, that in *T. dyspelor* the phalanges are less numerous than in *T. proriger*.

2. A second characteristic is the *marked broadening and shortening of the 5th metapodial* in both manus and pes, but especially in the pes. The carpus and still more the tarsus, on the postaxial (ulnar and fibular) sides are abbreviated. The result is that the 5th digit is drawn towards the body ; its elements and joints alternate with those in the I.–IV. digits; as a whole it is set wide apart. Williston has recently shown that the epidermal fin web conforms in its contours to this peculiarity.

3. A third characteristic is the *alternation of the joints in the 1st and 5th digits* with those in digits 2, 3, 4. The pes further agrees with the manus in the expansion of the proximal part of metapodial I., and the shortening or drawing up of the first finger, whereby the middle points of the phalanges of Digit I. come opposite the joints of the phalanges in Digits II., III., IV., thus greatly strengthening the paddle as a whole. A similar adaptation by alternation of the phalangeal joints is observed in some of the Plesiosaurs, in which it is carried to an extreme, for the phalanges of all the digits alternate.

This specimen affords an exceptionally favorable opportunity for a restoration of the skeleton. This interesting work has been accomplished by coöperation. Dr. W. D. Matthew kindly undertook a natural-size drawing of the entire animal, succeeding especially in rearranging the vertebral column and skull. Mr. Horsfall completed the details of the skull by careful measurement and comparison with the drawings of Merriam and Williston. Dr. McGregor and the writer restored the paddles and the sternum.

The drawing is upon a one-eighth scale. There was probably a small rib upon the third and fourth cervicals which has not been indicated. The cervical intercentra are restored from a fine specimen of *Platecarpus*.

One of the most important features of the restoration sprang from the discovery that the cartilaginous ribs of the left side are practically in their normal relations. This fact enabled us to locate definitely the lower end of the ten true ribs, the sternum, the epicoracoids, and at the same time fix the position of the fore paddle with reference to the skull.

As above noted, the ribs were found to resemble those of *Sphenodon* much more closely than those of *Varanus*. They are thus given in the restoration the angle, position, and foreshortening characteristic of *Sphenodon*, as the narrow anterior part of the chest expands into the broader walls of the abdomen. The ribs in the plate are perhaps a shade too heavy.

The upward curvature of the tail is designed exactly as the vertebræ lie in the specimen, for the reasons already discussed.

RESTORATION OF THE ANIMAL.

In the restoration of the animal, Mr. Charles Knight has taken advantage of all the information afforded by Professor Williston's collections and descriptions, and of our detailed study of this fine specimen.

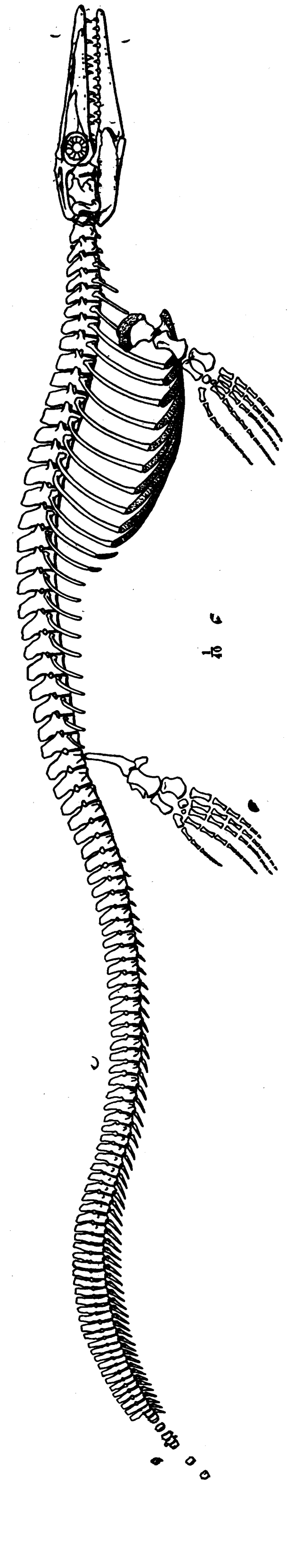

FIG. 2. Reconstruction of the Ram-nosed Tylosaur, after drawings, by W. D. Matthew and Bruce Horsfall, under direction of the author. $\frac{1}{40}$ nat. size.

FIG. 3. Restoration, by Charles Knight.

The animal was first carefully modelled upon a one-ninth scale.

Tylosaurus was a very powerful sea swimmer, propelled chiefly by the lateral motions of the body and tail. The caudal fin was a broad expansion along the dorsal line. The proportions can be precisely determined. The fore and hind paddles were similar in action and played a subsidiary part in guiding the animal, but were effective in the less rapid motions of the body. The indentation of the paddle border between the 4th and 5th fingers is upon Williston's authority. The nuchal fringe is also from this author's recent description of *Platecarpus*. The epidermal scaly covering is from Chancellor Snow's account of the *Tylosaurus proriger* covering. The expression of the top of the skull resembles that of *Varanus*, but in other points there is a wide departure from the Varanoid type.

The facts derived from this skeleton do not strengthen Baur's extreme opinion as to the intimate connection of this type with the Varanidæ. Besides the secondary degenerate adaptation to marine life shown in the girdles and appendicular skeleton, there are certain fundamental differences in the basioccipitals and ribs, in fact in all parts of the skeleton. These differences fully balance or overweigh the likenesses, which have long been dwelt upon by Cuvier, Owen and Baur, between the Mosasaurs and Varanoids, and do not even justify the assertion that the Varanidæ and Mosasaurs sprang from a common stem. The Mosasaurs are a very ancient marine offshoot of the Lacertilia, retaining certain primitive and generalized Lacertilian characters and presenting a few resemblances in the skull to the Varanoids; they are very highly specialized throughout for marine predaceous life, and constitute a distinct subdivision of the order Lacertilia.

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COLUMBIA UNIVERSITY.

THE INDIANA UNIVERSITY BIOLOGICAL STATION.

THE advantages of biological stations for purposes of research and instruction have had many advocates in recent years.

"There can be little doubt" says Parker, "that the study of zoology is most profitably as well as most pleasantly begun in the field and by the seashore, in the zoological garden and the aquarium." "The establishment of biological stations has done more to advance the study of zoology than any other one thing in this generation," says Conklin. "Certain desiderata are evident," adds Kofoid, "more biological stations, so that the conclusions arrived at in one locality may be extended and corrected in a score of others; and finally some biological Froebel, who shall demonstrate the disciplinary and cultural value of ecology as a field of biological instruction and establish a standard for others to imitate. In their work we may look for the happy combination of the sympathetic observation of the old-time naturalist, the technical skill and searching logic of the morphologist, and the patient zeal and ingenuity of the experimental physiologist, a combination, let us hope, that shall unlock not a few of the secrets of the world of life."

"It is unquestionably true that the tendency within recent years" says Ward "has been to make the university trained scientist a laboratory man, unacquainted with work out of doors and among living things. * * * Thus, both through the influence of the investigators in the case of those stations which do not carry on directly any educational work, and through the teaching of those which do conduct summer instructional courses, new life will be instilled into the teaching of natural history throughout our country."

The Biological Station of the Indiana University was planned with a well defined object in view, the study of the variation of